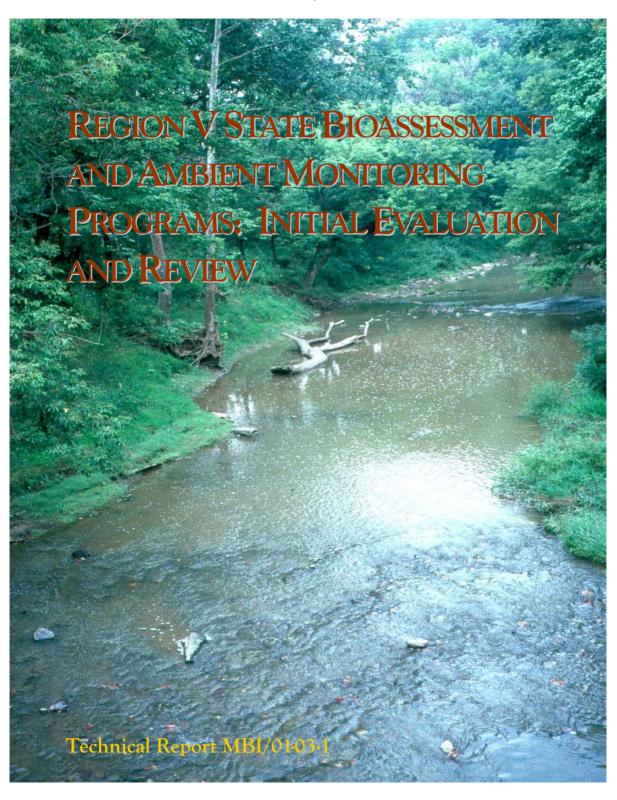
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# Region V State Bioassessment and Ambient Monitoring Programs: Initial Evaluation and Review

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Final Report

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#### **Executive Summary**

The purpose of this report is to provide an initial assessment of the current status of the monitoring and assessment programs in the Region V states and initiate a process to determine what is needed to improve the capacity and quality of those programs. This review specifically emphasizes biological assessment as a critical linchpin to the success of state monitoring and assessment programs. Specifically, the report focuses on the use of biological assessments to support the integrated assessment of status and trends, reporting, and other primary water quality management programs (WQS, planning, TMDLs, permitting) for aquatic life uses. It was prepared based on information gathered during on-site interviews with each state that took place in January 2002, information that is published by each state, and other information and experiences gained by MBI in supporting various U.S. EPA and state projects. Furthermore, the extent of overlap with national and regional EPA initiatives was exploited and evaluated whenever possible. The guiding principles of this report are based on the belief that monitoring and assessment programs should achieve the highest levels of standardization, rigor, reliability, reproducibility, accuracy, comparability, comprehensiveness, and cost-effectiveness that is reasonably attainable under current technologies. Achieving these depends largely on the ability and willingness of states to access and effectively execute the use of that technology.

While all of the states operate monitoring and assessment (M&A) programs, the quality and makeup of each varies widely in terms of organization, design, indicator development and use, and extent to which water quality management programs are directly supported by M&A. The assessment of status for 305b reporting and 303d listing purposes is a significant, and in some cases the *de facto* driver of state M&A programs. The recent emphasis on TMDLs and now the CALM process has amplified this dependence. However, there is evidence that an over-emphasis on this function of M&A can deter the ability of states to address emerging issues such as refined uses, use attainability analyses, and improved integration between and within water quality management programs in general.

The report is organized by the major program areas addressed in the interview process: Monitoring and Assessment, Reporting and Listing, Water Quality Standards, Assessment and Integration, and Biological Monitoring and Assessment. Each section was subdivided into a summary and description of general findings, major issues and challenges, and program implications and recommendations. A principal goal of this review is to determine the status of the biological M&A programs in each of the six Region V states, with emphasis on how it is integrated with other monitoring tools and programs and how it used to support *all* water quality management programs. While there has been a great deal of emphasis on the role of M&A in producing reliable estimates of status, this review focused on how the M&A framework simultaneously supports baseline water quality management functions such as water quality standards (WQS), watershed assessment and management (including nonpoint sources), TMDLs, and permitting programs such as NPDES permits, CSO/SSO, stormwater phase I and II, 404/401 dredge and fill, and other related issues (e.g., CAFOs).

The report also includes information regarding important details about key technologies and approaches that will be needed to successfully address many of the findings and recommendations of this review. These are appended to the report and include the key conceptual underpinnings, elements, and concepts of an adequate approach to M&A and surface water monitoring design options. Such detail is necessary to develop a blueprint by which the Region and the states can better develop an integrated program that will address deficiencies noted by recent reviews (e.g., GAO 2000, 2003a,b; NRC 2001; Karr and Yoder 2004). Making informed choices about monitoring network design, indicators, and technical issues such as indicator development and calibration will need to be under girded by ongoing technical assistance and applied research aimed at answering specific questions before and as they arise. Gaining management understanding and appreciation for the principles of adequate M&A is crucial to realizing improved management outcomes. This includes addressing embedded issues that have thus far served as serious impediments and disincentives to the development of more comprehensive programs (e.g., negative perceptions of refined uses, impact on 303d listings, implications for permitting, policy of independent application, etc.). Managers must be engaged in and comprehend this process and understand the pitfalls of operating water quality management programs in its absence. The following are important highlights of the findings and conclusions:

#### Monitoring and Assessment Issues

- Each Region V state operates an active M&A program, which includes biological, habitat, and chemical/physical sampling methods, indicators, and assessment techniques. Each state believes that current resources are insufficient to meet present and future M&A demands (true of biological assessment in particular). This not only includes staff, facilities, and logistical support, but also includes technological needs in terms of sampling designs, indicator development, data management, data analysis, and assessment and reporting.
- States are genuinely interested in further developing and improving their M&A programs.
  Regional support should be made available via direct assistance to support detailed technical
  assistance with the development of state monitoring strategies and implementation of
  improved monitoring programs. Grants should also emphasize the types of applied research
  that are needed to provide improved and new tools, indicators, and integrated assessment
  processes.
- Although M&A programs have recently become a more visible priority for the states, each receives varying levels of comprehension and understanding from their respective program management. This ranges from solid conceptual understanding and a genuine interest in how the results can be used to support water quality management to a principal interest in singular M&A derivatives (e.g., 303d listings) and an acceptance of limited programs. It is recommended that training and orientation be developed and aimed at program managers to accomplish a greater appreciation of the need for and utility of improved M&A.
- There is a need to better frame and organize the issues and questions that determine M&A design and use. This includes explicitly communicating how adequate M&A can improve and

streamline water quality management end outcomes and what is required to attain truly adequate M&A. This includes the conceptual principles and processes outlined in the report's appendices.

- Water quality management in most states is focused primarily on administrative outputs, especially in the permitting and TMDL programs. The explicit disconnection of administrative actions (i.e., termed outputs after GAO 2003a) from the M&A program has the effect of limiting the further development of the latter as an *end outcome* of water quality management. Even in states with well-developed and integrated assessment processes, there is tendency to digress to a principal reliance administrative outputs. Successful implementation of an environmental outcomes driven approach requires adherence to the principles outlined in the appendices and time to develop and implement the supporting indicators and integrated assessment processes. Accomplishing this in each state first requires an assessment of where the state M&A program stands in terms of attaining the professionalism, technology, facilities, and process needed to execute an environmental outcomes driven approach to water quality management.
- M&A program design in some states has been driven predominantly by status. This mirrors a similar emphasis by U.S. EPA at the national level. An important question remains: does an emphasis on status affect the ability of state M&A programs to support other water quality management program needs at the same time? Perhaps the greatest influence of this issues is on spatial sampling design, which ultimately influences the usefulness of M&A to support all water quality management program needs.
- A number of spatial monitoring designs are employed by the Region V states; the attributes of each are described in detail in the appendices. However, there are two strategic approaches being employed in Region V. One approach attempts to cover all aquatic resources within a 5-year cycle and represents an important trade-off emphasizing statewide coverage at the expense of spatial detail due to limited resources. The second approach opts for concentrating available resources emphasizing a spatially intensive approach in individual watersheds. In the latter, states have made the opposite trade-off, favoring spatial intensity and detail over statewide coverage. In these cases, complete coverage of the state is accomplished over a longer time frame (e.g., 10-15 years or more) or 100% coverage is not an overriding goal, with subsets of assessed waters used to evaluate long-term trends and program effectiveness. There are important consequences involved with these trade-offs, which are in need of a more critical and thorough evaluation.
- Assessment error tendencies and biases in different types of indicators used by the states needs to be better understood and documented. The propagation of type I and II assessment errors can occur as a result of these choices, with the latter being more prevalent in programs that emphasize surrogate indicators. The assessment "trickle-down" affects all resulting management products including impaired waters listings; it is a major source of inconsistency between the states (NRC 2001).

• The role of a consistent, standardized, and robust M&A program to produce a spatially robust dataset that supports applied research and development is largely unrecognized by the states and EPA. Yet this strategic function of M&A is critical to the continued improvement of water quality management. This type of support is critical to the refinement of WQS (i.e., designated uses and criteria), indicators (e.g., appropriate roles and process), assessment tools (e.g., improved chemical, physical, and biological criteria), and implementation tools (e.g., better TMDL development). Some of the Region V states showed tangible evidence of a process to support the type of research and development process that is needed to achieve this vital program function, but it varies widely in terms of consistent conceptual understanding and support.

# Water Quality Standards: Designated Uses

- Refined uses were identified as a critical developmental and implementation need in the NRC (2001) TMDL report as a replacement for the prevalent one-size-fits-all approach employed in most states. This would serve to more appropriately scale protection and restoration requirements to the capabilities and potentials of individual water bodies, thus making assessments of status more accurate. This is a pivotal issue for the Region and the states and will be a national program priority in the near term. This is also consistent with the U.S. EPA headquarters initiative and working group on refined aquatic life uses.
- Use designations in four states consist of either general aquatic life or fishery based uses. Only one state has a fully developed set of refined uses that are codified in the WQS. Use attainability analyses (UAAs) are used extensively in two states, sparingly in three states, and not at all in one state. The one state with refined uses is where UAAs are employed as a routine outcome of M&A. Some states are reluctant to develop refined uses due to uncertainties in terms of the resources needed to manage them, the difficulties in supporting and maintaining the administrative rulemaking process, and concerns about abuses such as inappropriate downgrading.
- The value of M&A in support of the development of improved and refined water quality criteria, designated uses, and implementation tools is generally not recognized by most states. Making this connection is essential to improving its use and meeting the goals described by this review. Much more needs to be done in terms of communicating the benefits of refined and tiered uses.

#### Status and Trends Reporting

Determining status is the principal driver of M&A in several states. The 305b process in all of
the states drives the 303d list, in part. In some states the 303d list is a subset of the 305b
impaired waters list while in others it is nearly identical. Only one state reports trends in
aggregate status (i.e., statewide or region wide) over a significant time period. Most states
either do not have sufficient data over a sufficient time period or do not have it sufficiently
organized to analyze and show trends.

• While the 305b reporting process has been supplanted by the Integrated Report, the basic M&A process still has the potential to be an effective filter for the 303d process. However, a general lack of discipline in the level and types of data that are "admitted" into the assessment process affects its ability to fulfill that role. Dealing effectively and systematically with the underlying issues outlined in this report and the appendices should result in a more consistent database and assessment process for producing more reliable outputs like 303d listings.

#### Biological Assessments and Biological Criteria

- All six Region V states operate biological assessment programs with at least two organism groups sampled on a routine basis. Most commonly macroinvertebrates and fish are sampled in rivers and streams, with some states adding algal indicators. Some states are developing indicators for other waterbody types including higher plants and other aquatic invertebrates and vertebrates in wetlands and primary headwater streams. The development of biological assemblage indicators for lakes and reservoirs has lagged behind these other waterbody types, although noteworthy efforts exist in at least two states.
- Variability in terms of methods, protocols, equipment, and assessment procedures exists
  between the states. The significance of these differences are variable and range from
  inconsequential to significant, the latter of which influences the effectiveness and utility of the
  resulting data and assessments. There is a need to compare the net effect of different methods
  and protocols between states to objectively determine if different methods, equipment,
  protocols, etc. have a significant influence on the resulting biological assessments. A
  standardized framework for developing biocriteria is needed to guide the states in this process.
- One Region V state has developed and adopted numeric biological criteria in the WQS. The remaining states are in various stages of developing and working through the process from which numerical biological criteria could be developed. At least two other states have adopted a narrative biological criterion and one of these has a plan to develop numerical biocriteria.
- Some states questioned the need to formally adopt numeric biocriteria when they see their current biological assessment framework as delivering the same end result. Some face internal barriers to developing biological criteria, the most prevalent of which is a perceived negative impact on NPDES permits.
- The policy of independent applicability has historically been seen by the states as a prohibitive
  issue for the eventual adoption of biocriteria. Some, but not all, of the Region V states echoed
  this view. In terms of ambient assessments, at least four adhere to a weight-of-evidence
  approach; one state strongly advocated an adherence to independent application.

#### **Principal Recommendations**

Building and maintaining a capacity to conduct integrated assessments that serve multiple water quality management program needs is the highest priority identified in this review. This means that in addition to the collection of adequate chemical, physical, and biological data, a consistent and meaningful process for translating that data into information and assessments must be developed. Such an approach requires the intellectual capacity to execute and communicate the results and effectively translate these into criteria, standards, plans, and management actions. While we recognize the limiting influence of current budget and administrative issues, we strongly recommend that this be accomplished in-house as much as possible. This better institutionalizes the conduct and use of M&A tools, information, and outputs within the state program. The most critical needs for each Region V state M&A program are as follows:

- 1) Building and maintaining adequate M&A must become institutionalized, i.e., it must be an integral part of water quality management by validating the environmental **end outcomes** of management program **outputs**. This must be based on meeting the needs of programs beyond the determination status to include support at all scales, especially at the same scale(s) at which management is being applied.
- 2) Adequate facilities and resources are an equally important issue in each state. We found that each state provided some or all of the basics, but the capacity to deliver the quantity of assessments and at varying scales is an issue. Each state should have the capacity to support multiple field crews capable of conducting integrated assessments at different spatial scales. A more detailed analysis of FTEs and their utilization is needed to determine the resource, capacity, and technology needs of each state.
- 3) Better integration between different programs is needed, especially in how M&A supports all management programs without the need to create and maintain separate efforts for each. Some problems include disparate goals and how each program measures success (e.g., 305b may be measured in biological terms, yet NPS uses load reductions and chemical quality). This reflects the absence of a comprehensive and integrated approach to M&A and a lack of integration to how programs are managed. Adherence to the baseline principles of adequate M&A and sound indicator discipline would solve many of these disparities.
- 4) Better integration of M&A and WQS is needed, especially in the development of tiered uses and the simultaneous adoption and implementation of biocriteria. Adequate M&A and WQS is vital to the success of watershed based management programs and initiatives. Accomplishing this also makes standardized and robust environmental indicators, methods, QA/QC standards and best practices, assessment methodologies, and assessment criteria available to external users. By providing such a supporting infrastructure of indicators and WQS, state programs fulfill their custodial role for M&A and WQS. This not only makes the data and information produced by each state of sufficient quality and reliability, but makes it comparable and of a known quality. Other users, i.e., watershed

groups, academic institutions, the regulated community, and other organizations would have a consistent and standardized process to follow in conducting their own assessments. These latter efforts now constitute an important supplement to the baseline M&A provided by a state and would help fulfill many baseline M&A goals. Presently, the lack of such a systematic approach in most states results in the production of external data that is of highly variable quality, quantity, and reliability.

- 5) The water quality management programs that stand to benefit from an adequate approach to M&A must be willing to incorporate the findings of such in their programs, policies, and actions. This report documents how well designed and executed M&A can support better implementation and end outcomes in these programs. However, the management programs must be convinced that this is in their best interest. Thus far, there has only been limited success as most programs are driven by programmatic outputs, not environmental end outcomes. The former functionally serves as a strong deterrent to building and maintaining adequate monitoring and assessment. One example is the strong perception that resources to carry out administrative functions are either inadequate or insufficiently managed and allocated. Hence the emphasis frequently is on making the execution of management programs and the delivery of administrative outputs better, oftentimes at the implicit expense of monitoring and assessment. A major conclusion of this review is that producing better information about environmental end outcomes can achieve better administrative management programs, thus resulting in the streamlining desired in the latter and the environmental outcomes of the former.
- 6) If the benefits of M&A in terms of supporting all water quality management programs and activities is to be more fully realized, it must be performed routinely and regularly over long periods of time. Unpredictable support frequently debilitates two of the most important functions of monitoring and assessment; 1) building a systematic and consistent database that serves as a resource for developing new and improved tools and criteria, and 2) addressing emergency needs as they arise and developing trends through time. Examples of how long term databases have been used to support the development of new and improved tools and criteria and demonstrate changes through time need to be marketed to state managers.

# Region V State Bioassessment and Ambient Monitoring Programs: Initial Assessment and Review

#### INTRODUCTION

The Midwest Biodiversity Institute (MBI) was tasked by U.S. EPA, Region V to conduct an assessment of the Region V state bioassessment and ambient monitoring programs with emphasis on how data and information are used in support of water quality management programs. This was done to better define and understand the uses of M&A information in each state and determine the opportunities, incentives, challenges, and barriers to the fuller use of this information in support of *all* relevant water quality management programs.

This report was prepared based on the information gained during on-site interviews with each state that took place in January 2002, information that is published by each state, and other information gained later via additional interactions with the Region and the states. The interviews consisted of a two-day meeting arranged by the state representatives of the M&A and water quality standards programs and attended by other relevant water quality management program representatives. The interview template is appended to this report (Appendix A-1). State responses to the recently completed U.S. EPA bioassessment program evaluation (U.S. EPA 2002) and additional information that was made available that describes the state's use of M&A information was also reviewed for this evaluation.

The evaluation of each state program was focused on current, planned, and potential uses of M&A information in support of water quality management programs. This includes water quality standards (WQS), reporting and listing (integrated reporting, watershed assessments, 303d listings, TMDL development and implementation), planning, nonpoint source assessment and management, dredge and fill (404/401), and NPDES permitting as these represent the in-common elements of state water quality management programs. It is a fundamental premise of this evaluation that ambient M&A should function to support all relevant water quality management programs in addition to its more commonplace role of supporting status assessments. Determining the linkages to the state's water quality standards (WQS) and reporting (305b, 303d) obligations was especially emphasized as they are fundamental to the broader use of environmental data in management decision-making. This emphasis is consistent with contemporary efforts to revitalize and improve the use of environmental data in water resource management (ITFM 1992, 1995; U.S. EPA 1995a,b; Yoder 1998; NRC 2001; GAO 2000, 2003a,b) and emerging efforts at EPA to more effectively translate environmental data and indicators to defensible criteria and standards (e.g., refined aquatic life uses, biological criteria development and implementation, CALM process).

This review emphasizes the assessment of aquatic life related issues and concerns since aquatic life uses and criteria frequently drive many water quality management criteria and decisions. Aquatic life uses apply to virtually all jurisdictional waters, thus it is a universally relevant water quality management issue. It is recognized that there are other management concerns such as water

supply, human and wildlife health, and recreational uses that must be supported by different kinds of monitoring and assessment. However, programs that incorporate the underlying concepts and principles which support more detailed definitions of aquatic resource types and refined uses for aquatic life are better able to transfer the conceptual underpinnings and the improved technology this fosters to these other uses and issues. Simply put, a well conceived and integrated biological assessment program is a key underpinning of sound water quality management.

Biological indicators of resource condition and health serve as a key and integrative response indicator (Figure 1). This model outlines the process of linking stressors (i.e., the focus of water quality management) and how these affect and change the key attributes of aquatic resources (i.e., Karr's five factors; Karr et al. 1986) and measuring the integrated result of these interactions by measuring and interpreting a biological response. This supports a feedback-based process in which the interactions between stressors and environmental attributes that are neither additive nor linear (Karr and Yoder 2004) can be better understood through the integration of their cumulative effects as portrayed by the biological response. It is the correct measurement and interpretation of the biological response that is key to making this process work.

# The Linkage From Stressor Effects to Ecosystem Response

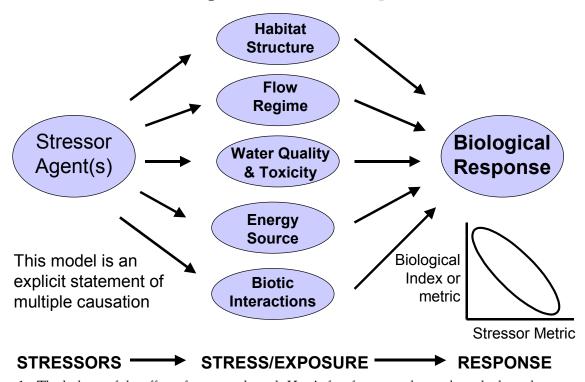


Figure 1. The linkage of the effect of stressors through Karr's five factors to the resultant biological response. The indicator roles represented by each category are identified in accordance with Yoder and Rankin (1998). [used by permission of J.D. Allan, originally presented at the 2002 U.S. EPA Refined Aquatic Life Uses conference; modified from Karr and Yoder 2004].

Important conceptual and methodological issues are detailed in the appendices and include a detailed description of preferred spatial monitoring design and indicator options (Appendix A-3) and *Important Concepts and Elements of an Adequate State Watershed Monitoring and Assessment Program* (Yoder 1998; Appendix B-1). These serve to communicate the concepts and technological details upon which much of this review is based.

#### Interview and Evaluation Process

Two-day interviews were conducted in each state in January 2002 and were arranged primarily through the WQS program manager. The first day consisted of a review and discussion of major programs that are supported by monitoring and assessment. Key water quality management program managers and staff were included at the discretion of each state. The guide for this process appears as Appendix A-1. A brief summary of each interview area included follows:

# Monitoring and Assessment Program

In terms of achieving the goal of supporting water quality management with indicators of environmental exposure and response, the state's M&A program is vital to achieving that goal. Monitoring includes the systematic collection of standardized chemical, physical, and biological data in the ambient environment. Assessment includes the analysis and transformation of data into meaningful information and assessments that include attainment/non-attainment determinations (status), changes through time (trends), characterization of impairments (extent and severity), associations between impaired states and causes (i.e., agents) and sources (i.e., activity or origin), and providing data and information to develop improved tools, indicators, criteria, and policies. This process should also support reporting that is required by the Clean Water Act (305[b], 303[d], 319, etc.) and that used by the state for allied purposes (watershed assessments, site-specific assessments, planning, TMDL development, etc.) without the need to develop separate or piecemeal monitoring efforts.

#### Reporting and Listing (305b/303d)

Reporting and listing here refers to the process of producing the biennial 305b report and the 303d list of impaired waters, both of which have received greater emphasis during the past decade. The information contained in these reports and lists are not only important to determining the effectiveness of a state's water quality management efforts, but are increasingly being used to set program priorities and allocate funding (i.e., Section 106 allocations). M&A information is an indispensable element of this process and how it is generated and used determines, in part, the accuracy of the statistics that are reported via 305b and 303d. This is a major issue as there is ample evidence of gross inconsistencies between states (Yoder 1998; NRC 2001). Thus, it is important to determine and understand the process used by each state in order to determine the reliability of M&A outputs. The problem is that any type of underlying data can be converted to a status and trend assessment – the key question becomes are the determinations of status and trends reliable and do they precipitate a consistent error bias?

#### Water Quality Standards

Water quality standards (WQS) provide the basis for water quality management in terms of benchmarks and criteria for designing management programs and judging the effectiveness of those programs. Of interest to the interview is the emphasis by U.S. EPA on refined aquatic life uses and biological criteria. Thus, the interview process emphasized these parts of the WQS process. Again, this is a major program area identified by the NRC (2001) as needing improvement, particularly in the development of refined uses, the use attainability analysis (UAA) process, and biocriteria.

#### Assessment Integration Issues

The integration of M&A information within water quality management programs is an important and emerging issue and ultimately fulfills the most important purpose of monitoring and assessment. In this process chemical, physical, and biological data and information assessed in an integrative manner and with respect to the most appropriate role of each (Yoder and Rankin 1998). It also includes the process by which administrative actions and responses by stakeholders to those actions are systematically and sequentially evaluated using an assessment process that relies on environmental end outcomes to communicate the success and effectiveness of administrative program outputs (Karr and Yoder 2004). Region 5 is also working with the states to develop shared environmental goals and milestones. This will partially fulfill efforts to implement the National Environmental Performance Partnership System (NEPPS), which promotes joint priority setting and planning through the increased use of environmental goals and indicators. The shared goals and milestones will be used to more comprehensively report to the public and environmental decision-makers about the status of water resources in the Region and document progress to meeting these goals. The goals and milestones will also be used to more effectively target programmatic efforts at the national, state, and local levels. It is important that we are able to document environmental successes so that they are recognized, funding is maintained at appropriate levels, and effective management programs continue to be implemented. Key to successfully achieving this level of integration is dependent wholly on the baseline information and indicators that comprise the process. Again, consistency between states in terms of key attributes of monitoring and assessment, indicators development, WQS, the assessment process, and reporting is critical to achieving the desired outcomes of integrated assessment.

#### Biological Monitoring and Assessment Program

A principal goal of this review process was an assessment of the state biological M&A programs. This included determining the extent to which biological data and information are being used to support water quality management programs and assess important goals and milestones. An onsite visit to the state's laboratory and field facilities and interviews with staff biologists was important to ascertain the infrastructural provisions for producing the quality and rigor of biological assessments that are needed to attain the programmatic support goals in each state. In 2002, each state completed a questionnaire in support of U.S. EPA's *Update of State Bioassessment Programs: Success of EPA's Technical Transfer Efforts and Building State Capacity* (U.S. EPA 2002). This portion of the interview process was focused on many of the same topics covered by the questionnaire and afforded an opportunity to amplify them and more thoroughly examine important details and context that could not be communicated in a questionnaire format. The

states were each requested to provide important program documentation and examples of outputs (reports, methods, protocols, etc.) that characterize the current usage of biological assessments and criteria.

# Summary of Monitoring Program Elements and Attributes (Tables 2 through 6)

The summaries presented in Tables 2 through 6 show the general levels of effort, summary of methods, monitoring designs, assessment process, and extent of water quality management program support provided by M&A in each Region V state. These were compiled from several sources including the interview process, methods and protocol documentation provided by each state, and information provided to U.S. EPA for the biological assessment program questionnaire. The information that is complied here is necessarily general and does not account for some of the important details embedded within a particular state program. Some attributes may also be in the process of being upgraded or changed, thus for specific and up to date information we advise checking with the appropriate state agency. We are aware of these efforts and their importance and they will be considered as important details are addressed through field visits and follow-up interviews with each state in the near future.

#### Goals of the Review Process

A principal goal of this review is to determine the status of M&A programs in each of the six Region V states, with specific emphasis on how it is being used to support *all* water quality management programs. While there has been much recent emphasis on the role of M&A in producing more reliable estimates of water resource status, this review also focused on how the same M&A framework should simultaneously support baseline water quality management functions such as water quality standards (WQS), watershed assessment and management (includes nonpoint sources), TMDLs, and permitting programs including NPDES permits, CSO/SSO, stormwater phase I and II, 404/401 dredge and fill, and other related issues (e.g., CAFOs). One major issue identified by this evaluation is that the design and operation of the M&A program in some states has been driven predominantly by status, rather than a focus on supporting all relevant water quality management programs *at the same scale at which each is being applied*. An important question remains - does an emphasis on status affect the ability of a state M&A program to support other water quality management programs at the same time?

This review was conducted based on the premise that ambient M&A should be designed and conducted to support *all* relevant aspects of water quality management *at the same scale at which the management is being applied.* This not only includes assessing and reporting on status and trends, but also supporting WQS, planning, watershed and nonpoint source management, TMDL development and implementation, and regulatory functions such as permitting (including compliance and enforcement). The review also focuses primarily on streams and rivers, although the lessons learned here should be applicable to lakes and reservoirs, wetlands, large and great rivers, and the Great Lakes (termed here as "ecotypes"). As with rivers and streams, the experience and applications developed by leading states will serve as examples for these aquatic ecotypes.

Table 2A. Attributes and characteristics of Region V State biological monitoring and assessment programs: Macroinvertebrate field protocols and applications.

State		Sampl	e Collectio	n Method	ds <sup>1</sup>		Fiel	Capa- city	Aquatic Ecotypes									
Agency	Quant. Sample	Effort Index	Qual. Sample	Effort Index	Stan- dard- ization	Index Period	Habitat Protocol	Sort	I.D.	#Sites/ Year	Primary HW	Head- water	Wade- able	Large River	Great River	Wet- lands	Lakes/ Res. <sup>2</sup>	Great Lakes
IL EPA	Multiple Habitat Dipnet	Sampling Surface Area	Dip Net/Hand Pick	Time (>60 min.)	NO	June 1- Oct. 15	Quanti- tative Transect	NO	Qual only <sup>3</sup>	80-120	_	_	•	•	_	_	_	_
IN DEM	Mod. Hester- Dendy <sup>4</sup>	Sampling Surface Area	Kick Net (1 m <sup>2</sup> )	Surface Area	YES	July- Sept.	RBP-type Assess- ment	NO	NO	100	_	•	•	•	_	0	0	_
MI DEQ	Mod. Hester- Dendy⁵	Sampling Surface Area	Dip Net/Hand Pick	Time (>30 min.)	YES	June 1 Sept.30	RBP-type Assess- ment	YES	Family level	700	_	-	•	_	NA	_	_	_
MN PCA	NONE	NA	D-Net/ Hand Pick	20 sweeps	YES	Septem -ber	RBP-type Assess- ment	NO	NO	90-100	_	•	•	•	_	•	0	_
OH EPA	Mod. Hester- Dendy	Sampling Surface Area	Dip Net/Hand Pick	Time (>30 min.)	YES	July 1- sept.30	Site description (No Index)	NO	Qual only <sup>2</sup>	450- 500	•	•	•	•	•	•	_	•
WI DNR	NO	NA	D-Net/ Hand Pick	Visual Based (2-3 min.)	YES	Spring/ Fall	Wisconsin Protocol	NO	NO	400	_	0	•	_	_	•	0	_

<sup>-</sup> Method and assessment are fully developed and used and numeric biocriteria are adopted in WQS.

<sup>•</sup> Method and assessment are fully developed and used, but not adopted in WQS (may include general narrative biocriteria).

O - Method and assessment are in development and in initial phases of usage.

<sup>- -</sup> Method and assessment are not developed.

<sup>&</sup>lt;sup>1</sup> Principal methods are in shaded boxes.

<sup>&</sup>lt;sup>2</sup> Includes biological assemblage assessments; **does not** include trophic state and other lake assessments or fishery management surveys. <sup>3</sup> Gross field identification to determine if new taxa are being included.

<sup>&</sup>lt;sup>4</sup> Used in lieu of kick net. <sup>5</sup> Used historically – no longer a principal method – replaced by qualitative method.

Table 2B. Attributes and characteristics of Region V State biological monitoring and assessment programs: Macroinvertebrate laboratory protocols.

State	Sorting Process			Identificat	ion & Cura	tion		Capacity	QA/QC						
Agency	Scan/pre -pick <sup>6</sup>	Sub- sample	Taxonomic Resolution	Where/ Who	Time Req'd.	Ref Collect	Archives	#Samples /Year	Check Samples	Sorting QC Check	Taxonomic QC Check	SOPs	QC Officer		
IL EPA	NO	300 orgs.	Lowest Practicable (Genus/ species)	IEPA Reg. Staff & Lab	4-8 hrs.	YES	YES; Retained At IEPA	80-120	NO	10%	Informal	YES	NO (Informal Process)		
IN DEM	YES <sup>7</sup>	100 orgs.	Family	IDEM Staff & Lab	3-4 hrs.	YES	YES; Retained At IDEM	100	?	10%	YES	YES	NO (Informal Process)		
MI DEQ	YES <sup>8</sup>	100 orgs.	Family	MDEQ Staff; minimal lab time	1.5-2 hrs.	YES	YES; Retained At MDEQ	700	?	?	?	YES	NO (Informal Process)		
MN PCA	YES	300-600 orgs.	Genus	MPCA Staff & Contract Lab	4-6 hrs.	YES	YES; Retained At MPCA	90-100	NO	YES	YES	YES	YES (mostly chemical)		
OH EPA	YES	Sample Split Up to 16X (n >500-1000)	Lowest Practicable (Genus/ species)	OEPA Central Lab; OEPA Staff	8-16 hrs. (quant.); 3-4 hrs. (qual.)	YES	YES; retained at OEPA	200-250 Quant.; 400 Qual.	YES	Each staff tested once/year	Informal	YES; In WQS	NO (Informal Process)		
WI DNR	NO	125 org. minimum	Lowest Practicable (Genus/ species)	U. Wisc. Central Lab; WDNR Field Staff	4-6 hrs.	YES	YES; retained at U. Wisc.	400	YES	?	?	YES	?		

Scan and pick for large and rare organisms.
 Scan for large and rare taxa not included in sample.
 Performed in field.

Table 3A. Attributes and characteristics of Region V State biological monitoring and assessment programs: Fish assemblage field protocols and equipment (symbols same as Table 1A).

State			Wadeable	e Methods			Non-Wadeable Methods						Aquatic Ecotypes						
Agency	Back- pack	Tow- boat	Electrode Config.	Effort Index	Other Gear	Samp- ling Direc- tion	Boat Electro- fishing	Gene- rator- Pulsa-tor	Electrode Array & Config.	Effort Index	Sam- pling Direc- tion	Primary HW <sup>9</sup>	Head- water	Wade- able	Large River	Great River	Lakes/ Res. <sup>10</sup>	Great Lakes	
IL EPA	Small Stream Only <sup>11</sup>	AC	Electric Seine	100 yds. or 1 meander	NONE	Up- stream	16' john boats	3-phase AC	Droppers	1 mile (1800 sec. Min.)	Ust. & Dst.	_	_	•	•	-	_	1	
IN DEM	Pulsed D.C.; Small Str. <sup>11</sup>	Pulsed DC (2.5 GPP)	Ring Anode; 2 netters	15X Width; 50 m min.; 500 max.	NONE	Up- stream	16' john boats	Pulsed DC; VVP- 2E	Electro- sphere; boat hull cathode	15X Width; 500 max.	Ust. & Dst. (both banks)	_	•	•	•	•	0	_	
MI DEQ	Pulsed D.C.; <15' Width <sup>11</sup>	Pulsed DC (2.5 GPP)	Ring anode; 2 netters	10-15X Width; 50- 200 m (>1800 sec)	?	Up- stream	Electro- fishing Barge	Pulsed DC; 5.0 GPP	Boom droppers (+); Bow droppers (-)	In Devel- opment	?	_	_	•	0	NA	_	_	
MN PCA	Pulsed D.C.; Small Stream	Pulsed DC	Ring Anode; 1- 2 netters	35X Width; 150-500 m	ОМ	Up- stream	John boat; Electro- fishing Barge	Pulsed DC; Type VI-A	Boom droppers (+); Bow droppers (-)	35X Width; 150- 500 m	Down- stream	_	•	•	•	-	O MnDNR	1	
OH EPA	Pulsed D.C.; Restric- ted <sup>11</sup>	Long- line; Towed Array	Net Ring Anode; 1 Assist Netter	Fixed Distance: 150-200 m <sup>12</sup>	Seines (Infrequ ent)	Up- stream	12-16' custom john boats <sup>13</sup>	Pulsed DC; 2.5-5.0 GPP	Boom droppers (+); bow droppers (-)	Fixed; 0.5 km <sup>12</sup>	Down- stream	O 14	•	•	•	•	•	•	
WI DNR	Pulsed D.C.; Head- water <sup>11</sup>	Pulsed DC (Wisc. Design)	Ring Anode; 2- 3 netters	35X Width; 100-500 m <sup>12</sup>	?	Up- stream	Custom john boats	Pulsed DC; Wisc. Design	Ring anodes; side-rail droppers	Fixed; 1 mile <sup>12</sup>	Down- stream	0	0	•	•	•	•	_	

Includes other vertebrates in addition to or inlieu of fish.

Includes biological assemblage assessments; **does not** include trophic state and other lake assessments or fishery management surveys.

Includes biological assemblage assessments; **does not** include trophic state and other lake assessments or fishery management surveys.

Includes biological assemblage assessments; **does not** include trophic state and other lake assessments or fishery management surveys.

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Includes biological assemblage assessments; **does not** include trophic state and other lake assessments or fishery management surveys.

Includes biological assemblage assessments or fishery management surveys.

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Table 3B. Attributes and characteristics of Region V State biological monitoring and assessment programs: Fish sample processing and laboratory protocols.

State		Field Data		Fie	eld Logis	stics	ldentifi	cation & C	uration			QA	/QC								
Agency	Para- meters	Anom- alies	Habitat	Crew Compo- sition	Hrs./ Site; Sites/ day	Samples/ Year	Where/ Who	Ref Collect.	Archives/ Vouchers	Verifica- tion	Methods Dev. <sup>15</sup>	Sorting QC Check	Standard- ization	SOPs	QC Officer						
IL EPA	Species, Counts, Weights, Lengths	NO	Qualitative Eval.	IDNR Crew (3-6)	1-3 hrs; ?	100	Field; IDNR Crew Leader	?	YES: INHS and SIU	YES; INHS and SIU	YES	?	? (Needs Improve- mentk)	YES	NO						
IN DEM	Species, Counts, Weights, Lengths	YES (DELTs)	Qualitative Eval.	2 FTE, 1 intern	1-6 hrs; 3 sites/ day	45	Field; IDEM Crew Leader	YES	YES: IBS Aq. Res. Center	YES; T. Simon	NO	?	YES	YES	NO						
MI DEQ	Species, Counts, Weights, Lengths	?	RBP Type Eval.	3 FTE; few or on interns	1.5-2 hrs; 4-5 sites/ day	100	Field; MDEQ Crew Leader	YES	?	?	YES	?	YES	YES	NO						
MN PCA	Species, Counts, Weights, Lengths	YES (DELTs)	Wisc. DNR Quant.; Qual. at Non-Wade	2 FTE, 2 Interns	1.5 – 4 hrs; 2-4 sites/ day	100	Field; MPCA Crew Leader	YES	YES; U of Minn.	YES; U of Minn.	NO	YES (in field by crew leader)	YES	YES	YES (mostly chemical)						
OH EPA	Species, Counts, Weights, Lengths	YES (DELTs plus all external)	QHEI	1 FTE, 2-3 interns	1-3 hrs; 4-8 sites/ day	600	Field; OEPA Crew Leader	YES	YES; OSU Museum	YES; OSU Museum	YES	In Develop- ment	YES	YES	NO (Infor- mal Process)						
WI DNR	Species, Counts, Weights, Lengths	YES (DELTs)	Wisc. DNR Quant.	1 FTE, 2 Interns	2-4 hrs; 2-3 sites/ day	250	Field; WDNR Crew Leader	YES	YES; UW Stevens Pt.	YES; UW Stevens Pt.	YES	?	YES	YES	?						

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 $<sup>^{\</sup>rm 15}$  Consistency of effort devoted to methods and assessment development.

Table 4. Structure and elements of water quality standards (WQS) and procedures related to the use of monitoring and assessment information in Region V States.

State	Aquatic Life Uses		Bioci	riteria <sup>16</sup>	Crit	teria Modifica	ations	Biological	Monitoring 6	& Assessmer	nt Support
Agency	Structure	Criteria	Narrative	Numeric	Site- Specific	UAAs	Other	Use Designa- tions	ALUS Support	Antide- gradation	TMDL Listings
IL EPA	General; Non- specific	Numeric Chemical	NONE	NONE	NONE	Limited for AQL (case- specific)	Adjusted Standards Reviews (20-30 total)	NONE	Informal Process (via 305b)	Biological Stream Classification (BSC)	305(b) Monitored Level
IN DEM	General; Fishery- Based (Warm & Cold water)	Numeric Chemical	Proposed	NONE	5-6 Cases Statewide	Very Limited	NONE	NONE	Informal Process (via 305b)	NONE	Subset of 305(b)
MI DEQ	General; Fishery- Based (Warm & Cold water)	Numeric Chemical	NONE	NONE	6-7 Cases (most for copper)	NONE (no <cwa use<br="">categories available)</cwa>	NONE	NONE	Informal Process (via 305b)	NONE	Close Subset of 305(b)
MN PCA	General; Fishery- Based (Warm & Cold water) with Limited Use	Numeric Chemical	1994; More specific adopted 2001	NONE	Three cases (ammonia & copper)	Class 7 (Limited Use) designations; 230 segments)	Outstanding Resource Waters	NONE	Informal Process (via 305b)	NONE	Subset of 305(b)
OH EPA	Tiered Warmwater Uses; Cold water fishery use	Biological & Chemical Criteria	Tiered AQL Use Descrip- tions	YES (Fish and Inverts; adopted 1990)	2 Cases	Routine Outcome of 5 Yr. Basin Process; >1500 since 1978	Biocriteria Caps on DMT; Biocrit. Derivation of chem crit.	Directly tied to bioassess- ment results	Codified in WQS via AQL and Biocriteria	Formal criteria & procedure	Direct translation of 305(b)
WI DNR	Tiered Uses	Chemical criteria	NONE	NONE	<10 Cases Statewide	Developing Guidance; 104 changes proposed	NONE	Indirectly influenced	Informal Process (via 305b)	NONE	Subset of 305(b)

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<sup>&</sup>lt;sup>16</sup> Formally adopted in State administrative code or regulations.

Table 5. Attributes and characteristics of Region V State biological monitoring and assessment programs: Watershed and water body assessment process.

	1	Silicit pro	1													
State	Watershed Assessment Design			S	patial Sam	pling Desi	gn		Assessment Process							
Agency	Temporal	Spatial	Fixed Station	Targeted Synoptic	Targeted Intensive	Prob- ability	Geo- metric	HUC Unit <sup>17</sup>	ALUS <sup>18</sup> Arbiter	ALUS Delinea- tion <sup>19</sup>	Assessment Chain-of- Custody <sup>20</sup>	Site Extra- polation	Cause/ Source	IA/Weight-of- Evidence		
IL EPA	Five-Year Rotating Basin Process	Statewide Coverage Every 5 Years	•	•	•	_	_	8 digit	Biological Assessment	Pass/Fail	Lead Biologist follows established guidance	10-25 mi. (per EPA guidance)	Structured process (based on chem./phys. data)	Weight-of- Evidence		
IN DEM	Five-Year Rotating Basin Process	Statewide Coverage Every 5 Years	•	_	•	•	_	8 digit	Chemical and/or Biological Assessment	Pass/Fail	Consensus Decision by Study Team	A "few" miles; mostly case specific	Follow EPA guidance; H,M,S	IA tendency		
MI DEQ	Five-Year Rotating Basin Process	Assess 80% wadeable in each cycle	•	_	•	_	_	11 digit	Biological and/or Chemical Assessment	Pass.Fail (Poor to fail)	Lead Biologist follows established guidance	Case specific (3- 5 mi. max.)	Follow EPA guidance; H,M,S	IA		
MN PCA	Rotating Basin Process	Statewide coverage by 2007	•	_	•	•	Future Design	8 digit	Chemical & Biological Assessment	Pass/Fail	Consensus Decision by Study Team	Varies (10 mi. on average)	Follow EPA Assessment Database	Weight-of- Evidence		
OH EPA	Five-Year Rotating Basin Process	Intensive Coverage of Priority Subbasins	•	-	•	0	•	11-14 digit	Numeric Biocriteria	Numeric, Increment- al Scale (Biocond. Gradient)	Lead Biologist asst. by Study Team; Mgmt. Approval	Case specific; 0.5-1.0 mi. default	Integrated Process; Lines- of-Evidence; Biol. Response Signatures	Weight-of- Evidence		
WI DNR	Five-Year Rotating Basin Proce	Intensive Coverage of Priority Basins	•	_	•	0	-	11 digit	Biological and/or Chemical Assessment	Pass/Fail	Lead Biologist asst. by Study Team	BPJ	Do Not use H,M,S	Weight-of- Evidence		

Principal method and design used to support WQ management.

Basin size within which watershed specific assessment is most commonly planned and conducted – gets at spatial intensity and resolution within a watershed sampling unit.

ALUS – Aquatic Life Use Support.

Pass/fail is assigned to 305b delineations of full, partial, non-attainment; incremental scale is assigned for calibrated numeric biocriteria that are fully implemented.

Process for developing site and/or reach assessment.

Method/design used in a secondary support role.

O - Method/design used on an infrequent or experimental basis.

Method and assessment are not developed.

Table 6. Relative degree to which major water quality management program areas are supported by monitoring and assessment in each of the Region V states.

State	_	sic orting	WQS Program					Watersheds/ NPS TMDL/303d			NPDES/Other Permitting								
Agency	Status <sup>21</sup>	Trend <sup>22</sup>	Tiered Uses <sup>23</sup>	UAA <sup>24</sup>	Refined WQC <sup>25</sup>	Anti- deg.	Site- Specific Crit.Mod. <sup>26</sup>	NPS/BMP Effective- ness	Hab- itat <sup>27</sup>	List/ Delist	TMDL Dev. <sup>28</sup>	WQ BELs <sup>29</sup>	Priority Setting	CSOs/ SSOs	Storm- water Ph. I&II	WET Limits/ Cond. <sup>31</sup>	Sever- ity/ Extent <sup>32</sup>	Enforce ment <sup>33</sup>	404/401 Dredge & Fill <sup>34</sup>
IL EPA	•	0	1	0	_	_	0	0	•	•	0	•	0	0	_	_	0	•	_
IN DEM	•	0	1	0	_	_	_	0	0	0	0	0	_	1	_	_	_	0	_
MI DEQ	•	0	-	_	_	_	0	•	•	•	•	•	0	0	_	0	_	0	_
MN PCA	•	0	_	•	0	_	_	•	0	0	0	0	0	_	-	0	0	0	_
OH EPA	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
WI DNR	•	0	0	•	_	0	_	•	•	0	0	•	_	_	•	_	•	•	_

- Well developed and routine process for using monitoring & assessment for at least 5-10 years; based on an integrated indicators framework process and comprehensive watershed design.
- Process and tools are available, but usage is no longer routine and occurs only on a project or issue specific basis.
- Project or site-specific use of monitoring & assessment consisting of upstream/downstream studies, paired stream studies (no comprehensive watershed design).
- Occasional or infrequent usage or under development.
- No support from ambient monitoring & assessment.

<sup>&</sup>lt;sup>21</sup> Basic attainment/non-attainment assessment for aquatic life use status including delineation of causes and sources of threat and impairment.

<sup>&</sup>lt;sup>22</sup> Sufficient information to report aggregate status of ecotypes over at least a 10 year period; does not refer to analysis of fixed station chemical trends.

Tiered uses that are developed based on assemblage assessments and which correspond to EPA's biological condition axis; does not include fishery based or general uses.

<sup>&</sup>lt;sup>24</sup> Includes any use of ambient monitoring data to change designated uses, both "upgrades" and "downgrades".

<sup>&</sup>lt;sup>25</sup> Ambient data is used to develop water quality criteria and/or influence the application or implementation of WQC (exclusive of pH, hardness, and other single modifiers).

<sup>&</sup>lt;sup>26</sup> Ambient survey data is used to ground truth EPA's site specific criteria process (water effects ratio).

Habitat assessment is linked to biological assessment and listed as a cause of impairment.

<sup>&</sup>lt;sup>28</sup> Includes using ambient data to support TMDL development and determine success of TMDL implementation beyond basic calibration data.

Water quality based effluent limits – ambient data is used to develop an assessment of the overall effect of the subject discharge on the receiving waters.

<sup>&</sup>lt;sup>30</sup> Ambient data is used to influence priority setting for NPDES permitting and/or SRF funding priorities.

Ambient survey data is used to develop WET testing requirements and/or effluent limits in NPDES permits.

<sup>32</sup> Assessment framework allows for determination of incremental departures and changes beyond pass/fail and communicates severity of problem over space & time.

<sup>&</sup>lt;sup>33</sup> Direct use of ambient survey data to support enforcement in terms of demonstrating that action is both legal and reasonable.

<sup>&</sup>lt;sup>34</sup> Direct support of general policy and site-specific decisions for the 401 certification of 404 dredge and fill permits.

#### FINDINGS AND RECOMMENDATIONS

This effort is intended to be investigatory as opposed to a comprehensive determination of the adequacy of the Region V state programs. That will come later through Regional review and determining adequacy consistent with the Comprehensive Assessment and Listing Methodology (CALM) implementation process, the Region V Indicators Initiative, and other ongoing efforts (i.e., Refined Aquatic Life Uses, Critical Bioassessment Program Elements) to improve state approaches to the assessment of aquatic life uses. As such, this review does not represent a detailed audit of a particular state program, but rather is intended to generate a focused analysis of the major issues that represent significant challenges for state M&A programs. It is also intended to introduce the development of an ongoing process by which the Region and states can together determine the status of the current M&A program, identify and assess gaps and shortfalls, determine incentives and disincentives, and determine ways in which M&A can be improved to meet the important goals and objectives shared by each. As such the findings and recommendations of this review are intended to highlight the major areas on which the emerging CALM, Indicator Initiative, tiered uses, and other processes can better focus. It was not possible to use all of the data and information collected during the interview process, but rather we are choosing here to focus on major conceptual and thematic issues first, with any missing details being covered as a consequence of a more painstaking and thorough process over time.

This section of the review is organized by the major program areas addressed in the interview process: Monitoring and Assessment, Reporting and Listing, Water Quality Standards, Assessment and Integration, and Biological Monitoring and Assessment. Each section is broken down into a listing and description of general findings, major issues and challenges, and program implications and recommendations for each subcategory.

#### Monitoring and Assessment Program

Monitoring and assessment includes the design, purpose, and conduct of how environmental data are collected from a spatial, temporal, logistical, and strategic standpoint. Subcategories included here include monitoring program concepts, spatial design and scale, resources and facilities, data management, and reference condition. A brief description of each state's M&A approach and program appears in Appendix A-2.

#### Monitoring Program Concepts and Development

Some states specifically indicated a need to frame M&A issues better and in more detail; all of the states echoed this at least indirectly. We believe that all states share the vision of the ITFM and subsequent efforts that intend for M&A to play a central role in producing the data and information to more effectively guide water quality management. What is lacking is a complete understanding of the specifics and the potential and realized implications to water quality management programs such as WQS, TMDLs, and permitting. At least two states were interested in having an outside entity audit their programs and several were engaged in their own internal efforts. This is seen as an important and positive first step as it indicates a genuine interest in determining and ultimately using ambient M&A in support of water quality management. There

is uncertainty, however, about how much this is shared by upper management since it was evident that administrative outputs are valued as the primary measure of water quality management program effectiveness and success.

# General Findings

- States are genuinely interested in improving their M&A programs and all are actively using data to report on the status of their surface waters, most commonly wadeable streams and publicly-owned lakes and reservoirs. There is a range of sophistication in state programs ranging from a sole emphasis on status reporting to integrated uses of M&A to support key water quality management programs.
- All six states have produced a monitoring strategy and most believe this is the appropriate vehicle to communicate design and indicator quality specifications and objectives. Most have either been revised in the past 2-3 years or are in the process of being revised.
- M&A programs receive varying levels of support and understanding from their respective
  program management in each state. This ranges from solid conceptual support and a
  genuine interest in how the results can be used to tepid support and a more ready
  acceptance of a limited program. Gaining management appreciation and buy-in for the
  more comprehensive and integrated process envisioned in this review is essential to
  achieving the goals of this process.
- The proportion of resources dedicated to ambient M&A in each state varies and needs to be quantified in real terms (i.e., FTEs).
- None of the states rely extensively on volunteer monitoring as a direct substitute for their own efforts. Some states support extensive efforts to track and incorporate volunteer organization data into the 305b report, but limit the "regulatory" use of this information. The use of volunteer organization data is much more extensive and better organized for lakes than for streams and rivers.

#### Critical Issues and Challenges

- There is a need to better frame and organize the issues and questions that determine M&A design and use. This would also include explicitly communicating how adequate M&A could help and improve water quality management outcomes. This should include the principles and processes outlined in Appendix A-3.
- Water quality management in most states is focused primarily on the administrative outputs of specific programs, most commonly including permitting and more recently TMDLs. A disconnection between administrative actions and the results of M&A has the effect of limiting the further development of M&A in terms of resources, indicators development, criteria, and the integration of environmental information into water quality management. This is true even in the states with well developed and integrated M&A and environmental indicators processes. Improved management buy-in and reliance on M&A is critical to truly achieving environmental results based management (Appendix A-3).
- The propagation of assessment error and biases in different types of indicators needs to be better understood by most states. One of the most pressing problems in the use of indicators "taken at face value" is the inappropriate substitution of stress and exposure indicators for response indicators (Yoder and Rankin 1998). This has a strong tendency to

- propagate a type II assessment error, i.e., problems and impairments that actually exist are either under-rated or not detected at all. This has a "trickle-down" effect into all resulting assessment products including those associated with the TMDL process and impaired waters listings and other products such as State of the Environment Reports and national compendia (e.g., Index of Watershed Indicators, National Status Statistics).
- The appropriate role of volunteer monitoring data and assessments is a recurring issue that needs to be better understood and defined. This issue is of concern due to the pressure exerted by volunteer groups to use their data, the notion that it is "free", and legitimate concerns about the quality and reliability of the data and information. One issue is the perception of volunteer organization data as a low cost substitute for state agency collected data. This overly simplistic view needs to be examined from the standpoint of data quality objectives, technological rigor, the integrity of the assessment process, the integration of data into the direct support of water quality management, and infrastructure issues within state programs.

## Programmatic Implications/Recommendations

- Explicit documentation of the key elements and concepts of an adequate state watershed M&A program including guidelines and checklists of the various monitoring networks and indicators is needed to provide a blueprint for states to follow. Some of this is available in general and conceptual terms (e.g., CALM, Yoder 1998), but specifics in important areas are lacking. Making choices about monitoring network design(s), indicators, and technical issues such as indicator development and calibration will need to be under girded by applied research aimed at answering specific questions.
- Gaining management understanding and appreciation for adequate M&A is crucial to realizing improved management outputs and environmental end outcomes. This includes addressing embedded issues that have thus far served as serious impediments and disincentives to the development of more comprehensive programs (e.g., perception of refined uses, implications for permitting, policy of independent application, etc.). Managers must be engaged in and comprehend this process and understand the pitfalls of operating water quality management programs in its absence. An orientation/training session for managers is recommended as one possible approach to better communicating the virtues of improved M&A.
- The usefulness of data collected outside of the primary custodial agency needs to be evaluated by an objective process based on data and measurement quality objectives (MQOs/DQOs) that are defined by the state's WQS and/or monitoring strategy. It is essential that each state address this issue by first establishing *adequate* MQOs/DQOs that will meet the needs of water quality management and adequate monitoring and assessment and which follow current **best practices**. State's need to take the lead and establish these in-house prior to delegating this function, either directly or indirectly, to outside organizations. This will preserve the proper role of the state agency as the principal custodian of M&A and WQS and the essential integration of each.

#### Spatial Design and Scale

All of the Region V states operate a rotating basin approach as the principal M&A framework. All of the states have successfully shifted from a fixed station design and most still operate skeletal networks as an EPA program requirement. What differs between the states is the specific spatial design of the basin approach with respect to spatial intensity. It seems that EPA's historical emphasis on achieving 100% coverage of all water resource types within five years has driven some decisions on spatial design specifics. This also seems to be driven, at least in part, by an emphasis on status and trends and in response to past criticisms that M&A could not deliver on this important question. What has received less attention is the implication of these decisions on the ability to simultaneously support site and watershed specific water quality management questions and issues. Some Region V states have chosen to emphasize the former while others have emphasized the latter, each with its own consequences on the ability to deliver on other goals and objectives.

#### General Findings

• Each Region V state operates a five-year rotating basin assessment process employing one, both, or a combination of two general approaches; 1) a statewide approach with widely distributed sampling locations (targeted and/or probabilistic) intended to cover the entire state in five years and address status issues, or 2) a spatially more intensive design designed to provide information in support of key water quality program needs such as permitting, WQS, TMDLs in addition to status and trends.

#### Critical Issues and Challenges

- At the risk of oversimplification, there are two broad and different spatial design approaches being employed by the Region V states. The first attempts to cover all or a majority of wadeable aquatic resources within a 5-year cycle. Some states have used a probability design supplemented by selected targeted sites while others have relied on a targeted, synoptic approach. In each case the degree of extrapolation beyond single sampling sites can be large and some states follow the recent U.S. EPA CALM guidance by using a 10/25-mile "rule-of-thumb" for extrapolating single sites in wadeable and nonwadeable rivers and streams. In short, these states have made a trade-off emphasizing statewide coverage at the expense of spatial intensity and detail. The second group of states opts for a more spatially intensive approach at the expense of complete coverage within a 5year cycle. These states have made the opposing trade-off, favoring spatial intensity over statewide coverage. In some cases complete coverage of the state is accomplished over a much longer time frame (e.g., 10 years or more) or 100% coverage is not an overriding goal, with subsets of assessed waters used to determine long-term trends. There are, of course, important consequences involved with these trade-offs, all of which are in need of a more critical evaluation and documentation.
- States are being urged to improve status reporting given the emphasis on this activity by U.S. EPA at the national level. We need to seriously examine if this emphasis is resulting in a narrow focus of M&A and precipitating a consequence of making the data and information less useful for other purposes. For example, does a less intensive synoptic survey design, which is geared to assessing all waters in a given rotating basin cycle, make

the resulting data and information less useful to site and reach specific WQ management? (e.g., complex mainstem segments sampled with a small number of sites vs. 10s of sites – what do we miss?). And does this result in M&A being kept at "arms length" from water quality management (i.e., can WQ management claim undue credit for improvements that are inferred by broad scale M&A, yet which are not linked to the reach or site-specific resolution of management?)? Also, can water quality management claim credit for compliance with stressor indicators absent of the linkage with exposure and response via the hierarchy of indicators and lines of evidence processes outlined in Appendix A-3? The scale of M&A is an important consideration in this process.

• Another issue is that of sampling production in terms of sites sampled per unit of effort. The protocol employed by a state in terms of chemical/physical, biological, and habitat assessment can affect productivity. Here, again, there seem to be two divergent approaches. One is to employ what might be categorized as rapid assessment approaches, which take a 1-3 hours to accomplish in which several sites can be sampled in one field day. This approach generally employs representative sampling and qualitative techniques. The other approach employs more quantitative protocols, which take longer at each site resulting in fewer sites sampled in a field day. Some of these approaches also require a larger field crew. A key question is do the data and information produced by the more intensive quantitative methods offset the reduced productivity in terms of sites sampled and hence reduced spatial intensity and coverage? Do the more rapid and qualitative methods omit essential data and information? What are the programmatic implications in terms of spatial scale and resolution in terms of meeting key water quality management program objectives?

#### Programmatic Implications/Recommendations

- Spatial design in the basin assessment process is a critical issue because of the risks
  associated with the disadvantages of each individual approach. The broader, statewide
  approach may risk overlooking or underrating significant site-specific problems, which if
  known about, could have been addressed by refocused management programs. This
  approach also risks incomplete documentation of the extent and severity of indicator
  exceedences and responses.
- There is also the risk of having an incomplete database regarding stressor gradients and the biological condition axis due to the omission of specific types of impacts that occur only in proximity to specific types of sources, occur in specific aquatic ecotypes or regions, or the highest quality resources that occur in only a few selected locations.
- The spatially intensive approach has the disadvantage of taking longer to develop comprehensive listings and other tasks that require broad spatial coverage, and it can be vulnerable to statistical criticism and bias.
- Applied research is needed on this issue so that unambiguous guidance can be developed
  concerning the choices that the states have either already made or are in the process of
  making. States face a growing need to develop increasingly detailed and sophisticated
  M&A programs to support both contemporary issues and future needs. Resolving the
  conflict between resources and the needs universe necessarily forces trade-offs that can only
  be made from an informed and strategic perspective.

#### Resources and Facilities

Resources and facilities comprise the essential infrastructure of M&A programs. This includes not only the direct personnel who carry out sampling and analysis, but also supporting personnel in terms of management, laboratory, and data processing support. Facilities include equipment and space in which the equipment is maintained and housed, and laboratory facilities in support of basic sample processing.

# General Findings

- Each Region V state operates an active M&A program with complements of supervisory management and staff. Each state includes biological, habitat, and chemical/physical sampling and data collection methods and techniques. Each state operates structural facilities that include office, laboratory, and field staging and warehousing facilities.
- Each state has professional staff that are capable of conducting chemical, physical, and biological assessments and the associated field, laboratory, and data analysis tasks. With the exception of the Illinois fish assemblage assessments, all work is performed in-house. Some states utilize contractors to deal with excess capacity issues and backlogs and this practice is increasing as artificial personnel ceilings are imposed.
- Each state gave indications that their current resources are insufficient to meet the present and future demands that will be placed on M&A and biological assessment in particular. This not only includes staff, facilities, and logistical support, but also includes technological needs in terms of sampling design, data management, data analysis, and assessment and reporting.
- None of the states use volunteer monitoring data as a substitute for the role filled by their frontline professional staff. We were not made aware of any volunteer groups with the capability to meet the professional qualification, data quality objectives, or monitoring design necessary to function as a substitute or supplement to state programs. The only significant use of volunteer organization data is with the citizen lake monitoring programs that employ comparatively simple measurements and observations.
- Some states cited burdensome and lengthy hiring practices as a major impediment to better M&A production and progress. In at least one state, personnel policies make it difficult to hire qualified staff for positions requiring specific skills. States are being forced to utilize contractual support, but all would prefer to have in-house staff.

#### Critical Issues and Challenges

- All of the states face resource shortfalls in many areas including personnel, acquisition of personnel, and competition with other water quality management programs. These shortfalls have the net effect of precipitating bottlenecks in the timely production of assessments and unpredictability in terms of improving M&A programs with new technologies.
- M&A is frequently regarded by management as being less important than established regulatory programs and hence the resources are less apt to be increased and in fact may be usurped by these other programs. If M&A is to fulfill the goal of supporting a data driven water quality management focus (as opposed to issue driven), then resources must be stable

and predictable over time. The flow of data and information must happen routinely through time to in order for assessments to be available when they are needed.

# Programmatic Implications/Recommendations

- If we are to realize the benefits of M&A in terms of supporting all water quality management programs and activities, it must be performed routinely and regularly over long periods of time. Unpredictable support frequently debilitates two of the most important functions of monitoring and assessment; building a systematic and consistent database that serves as a resource for developing new and improved tools and criteria and addressing emergency needs as they arise and developing trends through time.
- Examples of how long term databases have been used to report trends and develop new and improved tools and criteria need to be marketed to state managers.

# Data Management

This is a high priority area of interest and need for the states given its critical function in the overall process of making M&A information usable and readily available.

# General Findings

- All of the states have either developed their own data management systems and/or have used the EPA STORET system to enter, store, retrieve, and analyze data. Each state allocates at least one FTE and most allocate up to 3 FTEs to this task.
- Each state identified various needs and shortfalls in terms of data management. These ranged from improving current systems, building new systems, and overcoming basic operational tasks such as data entry and retrieval. In-house programming support is needed to customize existing applications to fill the specific needs of individual states.
- There were mixed reviews about the utility of the new STORET system.

#### Critical Issues and Challenges

States need the ability to manage chemical, physical, and biological data simultaneously
and achieve the integration necessary to achieve the goals and objectives stated in this
review. This means seamless operation of databases and ease of access by users.

#### Programmatic Implications/Recommendations

• Data management is a critical function in the operation of an adequate M&A program. We suggest this as an important area for further follow-up and discussion among the states. We feel that more emphasis needs to be placed on functional uses of data within the custodial state agencies as opposed to the current emphasis of entry, retrieval, and sharing for external users.

#### Reference Condition

Reference condition is a fundamental aspect of adequate M&A programs. While it has been highlighted by the biological criteria process, it is essential to the assessment and indicator development process in that it accounts for naturally occurring patterns and variability. As such, it is important to the development of background thresholds and ranges of expected performance for

various chemical and physical parameters such as baseline chemical/physical properties (pH, hardness, temperature, alkalinity, etc.) and key chemical parameters (dissolved oxygen, ammonia, nutrients, and other selected pollutants in water and sediments, etc.).

# General Findings

• All of the states are either in the process of choosing or have developed a network of reference sites primarily for the development of biological indicators and criteria.

# Critical Issues and Challenges

There exist different levels of understanding and sophistication regarding the conceptual
foundation and development of reference condition among and between the states. Some
have fully developed and working concepts while others are still struggling with basic
concepts.

## Programmatic Implications/Recommendations

• There needs to be a consistent conceptual foundation for the development and use of reference condition between the states. This is one of the pivotal, operational areas of M&A that will determine the reliability and comparability of state products such as integrated reporting and 303d listing, WQS, and virtually any application of M&A in support of water quality management. As such, this should be a focus of Regional and state efforts in the near term, including the development of best practices.

# Water Quality Standards Program

Water quality standards (WQS) include designated uses and criteria used to determine the status of attainment of a use. In this review, the focus is entirely on the aquatic life uses. The critical importance of WQS to M&A and water quality management cannot be overstated. WQS provide the basis for assessment, implementation, and compliance. This is a key area that the NRC (2001) review of the TMDL approach identified as needing significant attention and development. This review focused on the structure of aquatic life uses, adjustments and refinement to water quality criteria, antidegradation applications, and use attainability analyses. Table 4 summarizes the characteristics and attributes of each state's WQS program and its use and application in support of water quality management. The attributes of Region V state WQS that pertain to this review are summarized in Table 4.

#### Aquatic Life Uses

Designated aquatic life uses are the key component of a state's water quality management program that essentially determines the level of detail at which that program operates. Recently, EPA's interest in refined uses has been exemplified by the Aquatic Life Uses working group composed of EPA offices, laboratories, academic institutions, and the states (includes three Region V states). Major products include the development of a biological condition gradient which is intended to unify biological assessment and biological criteria development efforts. Efforts related to this

initiative include exploring the use of biological criteria to refine and develop water quality and other criteria and improvements in how Use Attainability Analyses (UAA) are conducted.

#### General Findings

- Use designations in four states consist of general aquatic life or fishery based uses. One state has multiple fishery uses and one state has a fully developed set of refined uses that are codified in the WQS.
- States with general uses operate a default classification system. Those with refined systems designate individual streams and rivers.
- Use attainability analyses (UAAs) are used routinely in one state, recently in another state, sparingly in three states, and not at all in the remaining state. The state with refined uses is where UAAs are routinely employed as a management outcome of the M&A program. All other states employ a program of UAAs that are developed as a result of specific issues and requests.
- Most states have employed adjustments to water quality criteria and/or their application in permits. Most endorse the EPA site-specific criteria modification procedure, but this method has been used only a few times in any one state. One state has an adjusted standards process that essentially functions as a variance procedure.
- The use of M&A to support antidegradation is fully integrated in only one state; ancillary information drives this process in all of the other states.

## Critical Issues and Challenges

- Some states are reluctant to develop refined uses due to uncertainties in terms of the
  resources needed to manage them, the difficulties in supporting and maintaining the
  administrative rulemaking process, and concerns about abuses such as inappropriate
  lowerings of designated uses.
- An extensive database, consistent support in terms of stream and river specific assessments, and the necessary structure in the state WQS is needed to develop and implement refined uses. All of the states have the basic infrastructure that is needed to implement this system, but many lack the database and tools necessary to routinely use and maintain it. Again, this would be one of the outcomes of developing an adequate approach to M&A in each Region V state.

#### Programmatic Implications/Recommendations

- The value of M&A in support of the development of improved and refined water quality criteria, designated uses, and implementation tools is generally not recognized by the states. Making this connection is essential to improving its use and meeting the goals described earlier by this review.
- Refined uses were identified as a critical developmental and implementation need in the NRC (2001) TMDL report as a replacement for the prevalent one-size-fits-all approach employed in most states. This would serve to more appropriately scale protection and restoration requirements to the capabilities and potentials of individual water bodies, thus making assessments of status more accurate. This is a pivotal issue for the Region and the

states and should be a high priority in the near term. This is also consistent with the U.S. EPA initiative and working group on refined aquatic life uses.

#### Assessment and Integration

Assessment and integration pertains to the process by which M&A information is assembled and interpreted via an assessment process and then used to directly support and influence water quality management programs. It includes reporting and listing processes such as 305b reporting and 303d listing, which inherently include the determination of causes and sources that are associated with measured impairments. The reliability of impairment determinations and cause/source associations is determined by the capabilities of the environmental indicators used in the integrated assessment process. These are basic program functions that pertain to the determination of status based on monitoring data and the exceedences of chemical and/or biological thresholds and criteria. The attributes and characteristics of the Region V state water body assessment processes are summarized in Table 5.

#### Status and Trends

This is fulfilled by the Section 305b reporting process and includes the aggregate assessment of impairment by water body type. Each Region V state fulfills the basics of this process and maintains a database of impaired and threatened waters. Each state also produces and maintains a list of impaired waters as required by Section 303d, which is theoretically an extension of the 305b process. This, however, varies considerably between the states and the quality of 305b reports (NRC 2001).

#### General Findings

- Completing the 305b report is a principal driver of M&A in all of the states. Each state maintains adherence to the EPA waterbody system (now the Assessment Database) in reporting the results of the 305b process.
- The 303d list is driven in part by the 305b process in all of the states. In some states the 303d list is a subset of the 305b impaired waters list while in others it is nearly equivalent.
- Only one state reports trends in aggregate status over a significant time period. Most states either do not have sufficient data over a sufficient time period to show trends or the database is not sufficiently organized to produce a cohesive trend assessment.
- All of the states assign causes and sources to threats and impairments, but with varying degrees of detail, consistency, and confidence.
- Some states are reluctant to determine threatened waters due to the implications for listing and uncertainty regarding water quality management obligations. Other states believe that threatened waters determinations are essential to the protection of vulnerable and high quality waters.

#### Critical Issues and Challenges

The 305b assessment process has the potential to be an effective filter for the 303d list.
 However, a general lack of historical discipline in the types of data that have been allowed

- into state 305b reports deter the ability of this report to fulfill that role. This is much less of a problem in the states with a more structured approach to data quality objectives, indicators, and M&A design.
- Trend reporting is a critical function of M&A programs and can be used to more effectively guide and prioritize water quality management programs. A comparative lack of continuity in data management,, indicators, and design have deterred the production of meaningful assessment by the states.

## Programmatic Implications/Recommendations

• Ensuring consistency in status determinations and the eventual uses of that information is a critical issue in the Region. This ultimately resides in the adequacy of the state's M&A program. Demonstrating that addressing this issue will result in meeting other M&A goals and objectives is essential to gaining management buy-in and the resources that are needed to achieve it.

Integration includes the "assembly" of multiple indicators in a sequential process using each within its most appropriate role. This process has been described by U.S. EPA (1990, 1995b) and Yoder and Rankin (1998). Central to the success of achieving a high level of integration is the development of environmental indicators, which are essentially the measurable outputs of an adequate M&A program. As such, the implementation of an adequate M&A framework should naturally result in the desired degree of integration so long as the principles and process of sound indicators discipline is practiced. Subcategories that are reported here include environmental indicators development and usage and the sequential process used to achieve integration with water quality management.

# Environmental Indicators Development and Use

An environmental indicator is defined here as a scientifically valid and managerially useable measure that is capable of communicating information about the status of a resource and trends in that status. There have been numerous initiatives to develop processes and frameworks for the use of environmental indicators to act as effectiveness measures for water quality management programs. However, too few of these efforts have recognized or addressed the need for adequate M&A to undergird the essential information gathering and assessment processes. Simply stated, environmental indicators are only as good as the underlying data collection and assessment process. This is a critical area given the Regional shared goals initiative.

#### General Findings

Only one state has a fully developed process for the integration of multiple indicators in
making ambient assessments over space and time. None of the other states can currently
report temporal trends on aggregate water resource condition in a manner that is
consistent with previous indicators development frameworks.

#### Critical Issues and Challenges

 Consistent and standardized M&A is essential to the development of a robust and reliable environmental indicators and their use as effectiveness measures. This includes more than

- the collection of data and information, but the maturity of efforts that integrate this data and information into meaningful assessments.
- Key to having good environmental outcomes is a thorough understanding of the what,
  when, why and where of the ultimate uses of the assessment. This must be understood by
  upper management with buy-in from managers, front line supervisors, and staff. This is
  crucial to good performance by staff in the field and it ultimately determines the
  effectiveness and credibility of the entire approach.

# Programmatic Implications/Recommendations

• Given the status of most of the state M&A programs, the development of this process will take time. However, the efforts of the Region to assist the states with improving their M&A programs should lead to the ability to use environmental measures as envisioned by the shared goals initiative.

#### Biological Monitoring and Assessment

All of the Region V states operate biological monitoring programs and all employ the capability to use at least two organism groups, usually fish and macroinvertebrates. Each state has developed an assessment process for determining if the sampling results indicate an impairment of the biological assemblage. The results are used for reporting status in all six states - uses beyond status vary by state. Tables 2 through 4 describe the attributes and characteristics of the state's biological assessment program. A detailed checklist that will help determine the present status of the bioassessment program, how it fulfills the desired goals of monitoring and assessment, and in which areas the development of improved capabilities are needed is under development and will be piloted with the Region V states in 2004.

## Biological Assessment Methods and Procedures

How biological data is collected, the level of resolution in terms of sampling and taxonomy, standardization, and operator skill and training can individually and collectively affect the accuracy and adequacy of the data produced. Also, states must develop biological assessment procedures that are not only robust, but which can be performed in a cost-effective manner. Generally, a cost-effective bioassessment protocol is one that can be executed at a sampling location in 1-3 hours supporting sampling of multiple locations in a day, 10s of samples in a week, and 100s of samples in a year. Thus some balance between absolute comprehensiveness and adequate representation of an assemblage must be struck. For state programs, producing a larger number of sites sampled at a reasonable cost and investment of personnel is of critical importance.

#### General Findings

- All six Region V states operate biological assessment programs with the capability to assess two organism groups. Three states collect two groups at virtually all sampling sites, while the others selectively apply each group singly.
- Macroinvertebrates and fish are most commonly sampled, with some states emphasizing macroinvertebrates more than fish. A few states have the capability to assess algae and

- some have broadened to include higher plants and other aquatic vertebrates and invertebrates in wetlands and primary headwater streams.
- With one exception the states support and retain an in-house capacity to assess both macroinvertebrates and fish.
- All of the states retain qualified full-time biologists and employ interns to assist with field work during a summer-fall index period. A few states outsource some laboratory work to contractors.
- Variability in terms of different methods, protocols, equipment, and procedures exists
  between states. The significance of some of these differences is likewise variable and ranges
  from inconsequential to potentially significant, the latter of which could influence the
  effectiveness and utility of the resulting data and assessments for region-wide assessment
  purposes.

## Critical Issues and Challenges

- While there are general similarities between the Region V state biological assessment
  programs, there are some potentially important differences in methods and approaches
  between states. The critical issue is in determining the comparability of the biological
  assessment and how these affect the ability to fulfill key reporting and water quality
  management support functions.
- The net effect that some of these differences have on the eventual outcome of the resulting use of the biological data can be surmised at a general level, but others require further applied research and evaluation.
- Some differences in methods are the result of initial decisions made regarding how the
  eventual data and assessments might be used. In some cases, basing these decisions on a
  comparatively narrow set of goals and objectives has potentially resulted in a less
  comprehensive program.
- The development of biological assessment techniques should correspond to the U.S. EPA biological condition gradient so as to accurately discriminate along the gradient in an ordinal, if not linear fashion so that discriminatory power and resolution is increased beyond mere pass/fail pronouncements of status and beyond the present full/partial/non-attainment paradigm. Key to this will be an adequate resolution in terms of programmatic elements and attributes in WQS (refined uses and criteria) and M&A protocols and how reference condition is determined and how biological evaluation mechanisms are constructed and calibrated. The development of biological assessment procedures must be evaluated in this light and key areas of the process defined and highlighted. This also must be done with knowledge and insight about how M&A should support all aspects of WQ management, not just status and trends.
- Standardization between and among crews and operators is not only a critical issue and should be evidenced in the state's QA/QC procedures, but also practiced in the field. An important aspect of this is the attitude of workers towards the sampling. Much of field sampling is skill and effort dependent such that all involved need to have a positive attitude towards the work. This also means that everyone needs to have a good understanding about the importance of good data quality and how it potentially affects the results, particularly the quality of the results and the negative consequences of bad data.

This may be a case for dedicated crews rather than having one crew performing all or multiple sampling tasks.

# Programmatic Implications/Recommendations

• There will be a need to compare the net effect of different methods and protocols between the states, not as a means to second guess the individual development and use of specific biological sampling protocols, but to objectively determine if different methods, equipment, protocols, etc. exact a significant change or influence on the resulting biological assessment. This could be done by taking the more commonly used approaches and performing comparative sampling in different states. Without this type of direct comparison there is simply no way to determine if the resulting assessments of individual states are directly comparable and what types of errors are being accrued, if any.

# Biological Criteria Development and implementation

Biological criteria are narrative or numeric expression based on aquatic community data acquired through biological monitoring. These provide benchmarks for determining the status of aquatic life uses more directly and accurately than by using chemical water quality exceedences alone. The development and adoption of biological criteria is an important program priority for U.S. EPA and a growing number of states either have or are within a few years of adopting biological criteria in their WQS.

## General Findings

- One state has fully developed and adopted numeric biological criteria into the WQS two
  states have adopted a narrative biological criterion. The remaining states are in various
  stages of developing and working through the process from which biological criteria could
  eventually be developed.
- Some variability exists in key aspects of the state biological monitoring programs and includes methods, level of taxonomic resolution, and existing assessment criteria and decision benchmarks for attainment/non-attainment designations.

# Critical Issues and Challenges

- Some of the states questioned the need to formally adopt numeric biocriteria when they see their current biological assessment framework as delivering the same end result, particularly for status determinations. These states employ a narrative translator linked to their informal assessment criteria.
- Some states face internal barriers to further developing biological criteria, the most prevalent of which is the perceived impact on NPDES permits and the potential added burden for WQS rulemaking.
- The effect of the policy of independent applicability on biological criteria development has historically been seen as a deterrent to the further development and use of biocriteria. This was echoed by some, but not all of the Region V states. In terms of ambient assessment, at least four states adhere to a weight-of-evidence approach. Only one state strongly advocated an adherence to independent application.

# Programmatic Implications/Recommendations

• Biological criteria offer some substantial advantages in terms of improving the accuracy and capabilities of a state water quality management program. These advantages need to be better communicated to state program managers along with the value added aspects of the approach to water quality management program support.

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